

FACTORS INFLUENCING THE BIOLOGY  
AND MORPHOLOGY OF PARASITES

BY

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The aim of the present paper is to discuss some problems connected with methods of investigations on the specificity of parasites based mainly on Hymenolepididae parasitizing birds and carried out in the Department of General Biology and Parasitology of the Medical Academy in Warsaw.

Occurrence of parasites under natural conditions is the origin of long lists of final or intermediate hosts of many tapeworms. What can we learn from such lists? Numerous monographs and manuals quote them without mentioning what is the real meaning of a given host, especially the final host of the parasite constituting its natural environment. In other words, is it a proper, usual, sporadic, accidental or abortive host-parasite system? We do not even know very often what is the intensity and extensiveness of the infestation in a particular biotope, important for investigations on specificity. Such data may show that hymenolepidids in aquatic birds have host-ranges less extensive even than an order. The great number of species of Hymenolepididae of Anseriformes are characteristic for swans, geese, ducks and for other smaller taxonomic groups. E.g. the seven species out of the eleven found in *Cygnus olor* are common tapeworms of swans only under natural conditions in Poland, although there is a full ecological possibility of infestation of other Anseriformes living in the same biotope (Czapliński, 1975).

The mean intensity of infestation is connected with the age of the swans. Four species are more frequent and numerous in younger swans while e.g. *Gastrotaenia paracygni*, occurs in older swans. Some species of parasites are specialized even to the species of the host e.g. *Monasacanthus strepera* has been found till now exclusively and *Hamatolepis teresoides* almost exclusively in *Anas strepera*. On the other hand, some species e.g. *Sobolevicanthus gracilis* are less particular in their choice of the final host and can parasitize birds belonging to another order, thus being exceptions to the rule of Fuhrmann. It has been found in natural infestation of *Gallus gallus domesticus* and under another specific name, in *Columba livia domestica*, representatives of two different orders of hosts. Do these two host species form a specific or abortive host — parasite system? Without experimental verification of the entire life cycle of *S. gracilis* in these hosts, no answer to this question is possible. Misiura 1972 confirmed experimentally that hen and pigeon may serve as proper or final specific hosts of *S. gracilis* (Fig. 1). It is proposed that a host can only be regarded as specific for a particular species of parasite if its life cycle can be completed in it thus assuring full development of successive generations. Extensiveness and intensity of infestation under natural conditions are important but not fully satisfying data for the determination of a specific host — parasite system.

Fig. 1 shows the different adaptability of *S. gracilis* in final hosts. A similar problem has been studied by Olszewska with *Diorchis stefanski* (unpubl.) — Fig. 2. She obtained oncospheres not only from a known typical host — *Anas platyrhynchos* but from the turkey, too. However the oncospheres from turkey were unable to complete development in the intermediate host. It is not sure whether the negative result of experimental infestation of the host may be estimated as an unspecific system. The worker can meet many surprises: the oncospheres used for the contact with the intermediate host can be morphologically well developed, but they may have no infective activity. The oviposition depends not only on the host species but on its strain, too, as it has been shown by Jaroń (Fig. 3).


















ANSERIFORMES	<i>A platyrhynchos</i>			
	<i>A anser</i>			
GALLIFORMES	<i>G gallus</i>			
	<i>M gallopavo</i>			
	<i>P colchicus</i>			
COLUMBIFORMES	<i>C livia</i>			
	<i>S decapcto</i>			
ANSERIFORMES	<i>P domesticus</i>			
RALLIFORMES	<i>G chloropus</i>			

FIG. 1. — Adaptability of *Sobolevicanthus gracilis* in final hosts (After Misiura 1972, modified).










ANSERIFORMES	<i>A platyrhynchos</i>			
GALLIFORMES	<i>M gallopavo</i>			
	<i>G gallus</i>			
	<i>C coturnix</i>			
COLUMBIFORMES	<i>C livia</i>			
ANSERIFORMES	<i>Fasser dom</i>			

FIG. 2. — Adaptability of *Diorchis stefanski* in final hosts (After Olszewska unpubl.).

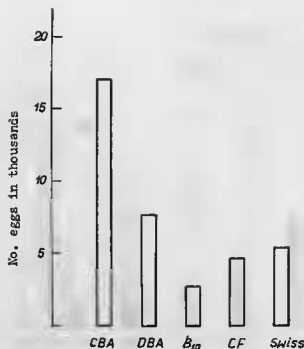


FIG. 3. — Average egg-output of *Hymenolepis nana* in five different strains of white mice (After Jaroń unpubl.).

The infective activity determined by the per cent of oncospheres able to penetrate the intestinal wall into the body cavity of the intermediate host is different and depends on its species as has been stated by many authors including Grytner-Zięcina (Fig. 4). The same author demonstrated the influence of the final host species on the infective activity of *Sobolevicanthus gracilis* oncospheres in *Heterocypris incongruens*. It was significantly higher when oncospheres were from hen beginning from the third passage (about 50 %) than from the typical host, the duck (about 23 %). This surprising phenomenon was well only in *H. incongruens*, not in another good intermediate host, *Cypridopsis vidua* (Fig. 5). I would like to emphasize the decrease of infective activity of oncospheres taken both from hen and duck from the IVth passage and tested in *H. incongruens*. This interesting phenomenon may be probably explained by artificial selection of genotypes adapted to development in a given final host species. The stability of the infective activity value takes place in the third and fourth passage through the same final and intermediate host species. The change of the final host species is expressed by change of the infective activity and even by change of the dimensions of eggs (Misiura 1973). *C. vidua* is a good example, demonstrating the role of the age of the intermediate host on the infective activity, which is significantly higher in immature females than in mature ones (Fig. 6). Grytner-Zięcina (unpublished) also remarked that infective activity of *S. gracilis* oncospheres is much higher in females than in males of *Notodromas monacha* (Fig. 7). Of course, it is necessary to remember that the infective activity of the oncospheres depends on their age and conditions in which they are kept. E.g. the infectivity of oncospheres of *S. gracilis* kept at 16-18°C declines rapidly and is entirely lost within 63 days after removal from the gravid proglottid. The age of the cysticercoids of *Diorchis stefanski* influencing the prepatent period is one of the possible biological criteria of specificity (Olszewska unpubl.). The author found the first infective to the final host cysticercoids on the fourth day after invagination of the scolex. Their development into adult tapeworms with oncospheres lasts 27-30 days while in cysticercoids 14 days old and older ones the prepatent period is stabilized at the level of 14-16 days.

Our knowledge about the biology and morphology of Hymenolepididae without saying about the variability of their biological and morphological features is very scarce. It is not necessary to

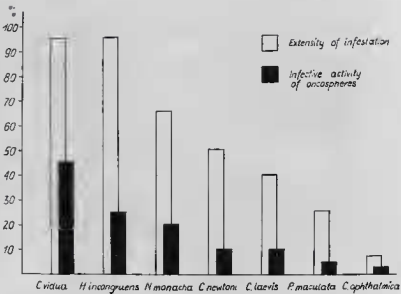


FIG. 4. — Infective activity of *S. gracilis* oncospheres in Ostracoda (After Grytner-Zięcina unpubl.).

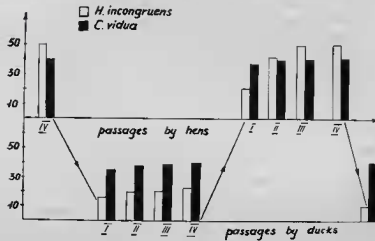


FIG. 5. — Comparison of *S. gracilis* oncospheres infective activity in *Heterocypris incongruens* and *Cypridopsis vidua*. Oncospheres were obtained in sequent passage through hens and ducks (After Grytner-Zięcina unpubl.).

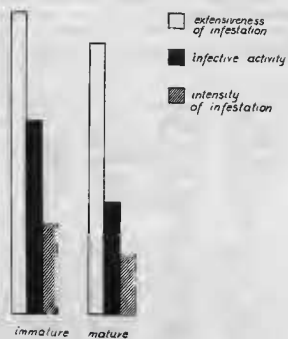


FIG. 6. — Infective activity of *S. gracilis* oncospheres in *Cypridopsis vidua* at different age (After Grytner-Zigoina unpubl.).

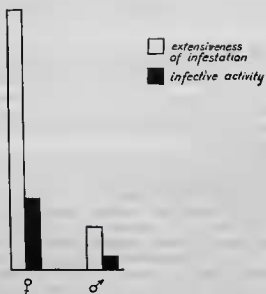


FIG. 7. — Infective activity of *S. gracilis* oncospheres in *Notodromas monacha* of both sexes (After Grytner-Zigoina unpubl.).

remind of the necessity of a good identifying of species in research devoted to the specificity. The topospecificity, distinctly expressed in many parasites, may serve as an additional ecological criterion for identifying species and deserves more attention. E.g. almost all the eight cestode species common in wild mute swans has its characteristic place in the alimentary canal (Fig. 8).

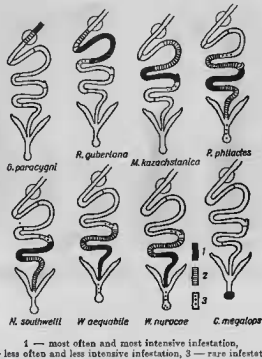


Fig. 8. — Topospecificity of tapeworms of the wild mute swan (After Czapliński 1973, 1975).

Valuable investigations on morphological variability of Hymenolepididae were begun experimentally by Misiura (1971) on *Sobolevicanthus gracilis* rostellar hooks. These hooks are one of the most stable characters of these tapeworms. She found an unexpectedly wide range of variability of the hooks length influenced by the intensity of infestation in the intermediate hosts. Similar results were obtained by Czapliński *et al.* 1978 in *Diorchis stefanski*. Olszewska (unpubl.) confirmed in this parasite species results known till now in *S. gracilis* only by Misiura (1971): the rostellar hooks complete their growth in the intermediate host.

Another morphological feature is the good visibility in fresh material of the structure of the envelopes of the oncosphere. *Fimbriaria fasciolaris* eggs were suspected to be very variable in shape and size. Experiments made by Wilanowicz demonstrated that there is a statistically significant difference between smaller eggs obtained from cestodes grown up in *Gallus gallus domesticus* and bigger ones obtained in tapeworms from experimentally infected *Anas platyrhynchos domestica*. What is more there are significant differences between eggs from various strobilae grown up in hens while such differences do not exist when comparing eggs from various strobilae grown up in ducks. It appears to me, that it speaks in favour of a morphological stability of the eggs in a proper and typical host — the duck and of its lack in an unusual host — the hen. However, in no case a similarity of these eggs to the two other types of eggs found under natural conditions, rowed with differently formed inner envelope and arranged in "packets", have been discovered. Thus a conclusion may be drawn that the shape of the entire egg is probably of taxonomic value for the genus *Fimbriaria* which consists of more species than hitherto described.

## CONCLUSIONS

1. Intensity and extensiveness of infestation under natural conditions are very important but not fully satisfying data for determination of a specific host — parasite system.

2. Not only the species of the host, but also its strain, age and sex are important factors influencing the biological features as infective activity of the larvae, topospecificity and even, morphological features as hook and egg size of tapeworms and may be valuable in research on specificity.

3. It is proposed that a host can only be regarded as specific for a particular species of parasite if its life cycle may be completed in it and full development of successive generations occurs.

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## DISCUSSION

WERTHEIM. — Everyone working with a group of parasites is aware of the great variability between specimens recovered from different hosts, however, there are few studies in which this variability is emphasized and analyzed. Dr. Czaplinski's extensive, quantitative study dealing with host influence on the morphology and biology of parasites is an important contribution to the methodology of studying parasite taxonomy and specificity.

COMBES. — Lorsque la fécondité d'un parasite décroît à la suite de passages successifs dans un hôte peu favorable, vous invoquez l'intervention possible d'un mécanisme sélectif. Or, une « sélection » a habituellement pour résultat une meilleure réussite du processus considéré. Pensez-vous donc que la sélection est réellement en cause ?

CZAPLIŃSKI. — We don't really know. Many factors may be involved.

EUZET. — Les infestations des hôtes dénitifs par *Sobolevicanthus gracilis* étant expérimentales, on peut voir dans ces résultats une bonne illustration du schéma que nous avons proposé avec COMBES pour expliquer la spécificité parasitaire.

Parmi les Oiseaux infestés, certains sont des hôtes potentiels, c'est-à-dire qu'ils sont inclus dans l'angle d'exigence du Cestode parasite. Seuls les Anseriformes sont des hôtes effectifs, car ils sont en contact avec les Ostracodes, hôtes intermédiaires. *Gallus* et *Columba*, hôtes potentiels, ne peuvent être infestés que s'ils franchissent (ou si on leur fait franchir) ce que nous avons nommé le filtre éthologique.

L'importance des résultats présentés par M. Czaplinski est que ce passage se traduit par une diminution de l'infestivité des oncosphères chez les hôtes aquatiques.

Mais est-ce que cela n'entraîne pas aussi des changements dans les potentialités du parasite ?

HENNACHE. — Les barrières géographiques peuvent être importantes aussi :

Dans nos élevages de Mallophages, les 2 espèces parasites du Nandou sont élevées sur des plumes d'Émeu. Dans la nature, l'Émeu ne peut être en contact avec ces espèces.